UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE

FOREST INSECT CONDITIONS in OREGON AND WASHINGTON

1938 - 1942

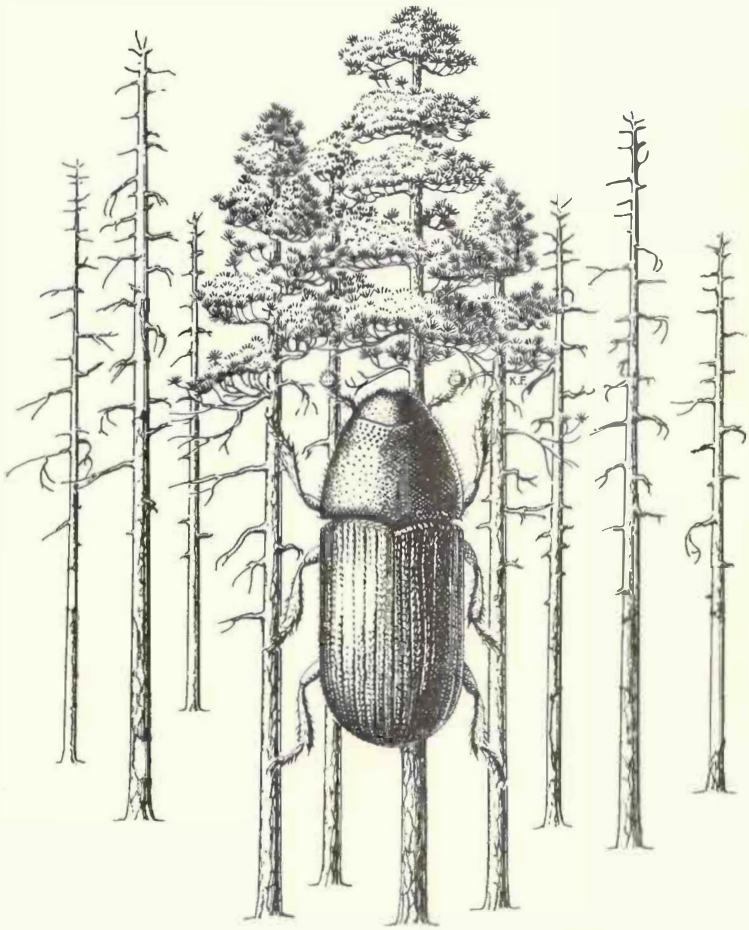

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TABLE OF CONTENTS

	Page
FOREWORD	
PART I. THE WESTERN PINE BEETLE PROBLEM	2
Review of Losses	2
Relation of Losses to Growth	4
Factors Affecting Losses	5
Losses by Subregions and Administrative Protective Areas	6
Control Program	14
Research Program	17
PART II. OTHER INSECT PROBLEMS	20
Insects Attacking Forest Trees	20
Insects Attacking Shade Trees	24
Insects Attacking Wood Products	25
PART III. APPENDIX OF STATISTICAL INFORMATION AND REFERENCES	28
Ponderosa Pine Check Plot Losses	30
Gross Ponderosa Pine Losses by Subregions	36
Pine Beetle Control Work	42
List of Laboratory Publications and Reports	46
INDEX TO SPECIES OF INSECTS DISCUSSED	57

FOREWORD

Since 1929, the Bureau of Entomology and Plant Quarantine, through the Forest Insect Laboratory at Portland, Oregon, has been assembling information on insects destructive to forest trees, shade trees, and forest products in Oregon and Washington. This information has been derived from three principal sources: (1) Annual forest insect surveys conducted in cooperation with the U. S. Forest Service, the Office of Indian Affairs, the National Park Service, and private timber companies; (2) field observations and research by the personnel of the Portland laboratory; and (3) reports received from many individuals.

With this information as a basis, a series of reports was initiated for the purpose of recording from time to time a comprehensive summary of the forest insect situation in the Pacific Northwest. These reports are intended primarily for timber owners, foresters, entomologists, and others who, though they do not have ready access to the numerous detailed office reports concerning specific insect conditions, are interested in what pests are active from year to year, what damage they cause, and what steps are taken to control them. The first report in this series covered the period from 1931 to 1933. The second was for the years 1933 to 1938. The third, covering the years 1938 to 1942, was prepared during the early part of the war when, because of wartime restrictions, it could not be processed and issued. Consequently, the statistical and other information it contains have been available only upon specific request.

Now that a reappraisal of the forest situation in all its aspects is under way, it seems advisable to bring the information regarding forest insects up to date and to make it generally available. This is to be done in two reports, the present one covering the period up to the early part of the war, and a second, more generalized report covering the war years. This procedure has been adopted because surveys during the war were inadequate for extending the loss tables and other statistical information characteristic of the first three insect conditions reports.

The following report covers the years 1938 to 1942. It is presented in three parts: PART I, THE WESTERN PINE BEETLE PROBLEM, is a discussion of the damage, significance, and control of this primary insect; PART II, OTHER INSECT PROBLEMS, is a review of the more important pests of forest and shade trees and forest products coming to the attention of the laboratory; and PART III, an Appendix of statistical information and references.

Upon request, the laboratory staff will be glad to supply technical advice on control methods or other problems involving forest insects. Any information regarding the existence of forest insect outbreaks or the occurrence of damage to wood products will be of assistance in making this service more effective.

PART I. THE WESTERN PINE BEETLE PROBLEM

Destruction of ponderosa pine by the western pine beetle (Dendroctonus brevicomis Lec.) has long been the most important insect problem in the forests of the Pacific Northwest. For over 25 years pine beetles have depleted the mature and overmature pine forests of Oregon and Washington more rapidly than the forests have grown. Consequently, the harvesting of ponderosa pine has developed into a race against time and the beetles. With this serious situation confronting timber owners and land-managing agencies, it has been imperative that the major expenditures for forest insect control and research in this region be devoted to this problem. Considerable progress toward a workable solution has resulted from this concentration of effort.

Review of Losses

The western pine beetle is native to the ponderosa pine region, and probably was killing overmature, decadent, and weakened pines long before man crawled from his cave. Only within the last 50 years or so was the western pine beetle recognized as a primary tree killer, and it was not until about 1917 that its potential destructiveness was generally appreciated. At that time a prolonged series of drought years began and caused a marked decline of tree growth in the interior type of the Great Basin. With this weakening of tree vigor, western pine beetle destruction mounted rapidly and timber owners began to recognize this tiny beetle as a new and serious menace to their timber properties.

In 1921 the Bureau of Entomology started a pine beetle survey program to provide information for control work in southern Oregon. These annual surveys, which were later extended to cover all east-side ponderosa pine areas in Oregon and Washington, yield basic data from which estimates of insect-caused losses are made. A resume of these estimated losses for eastern Oregon and Washington for the period 1921 to 1942 is given in table 9.

The 12-year period ending in 1942 witnessed the rise and fall of a major epidemic of the western pine beetle (fig. 1). This epidemic started at a comparatively low point in 1930, gained momentum in 1931, peaked in 1932, dropped off suddenly in 1933, and then subsided rather gradually through 1942. In 1938 there was an upturn of infestation, and from all indications another epidemic was impending. This proved to be only a minor flare-up that broke in 1939. In that year the steady downward trend was resumed and this continued through 1942 when an all-time low was reached. There was marked improvement in the growth of ponderosa pine concurrently with this break in infestation. Presumably the trees became vigorous enough to ward off a large portion of the beetle attacks.

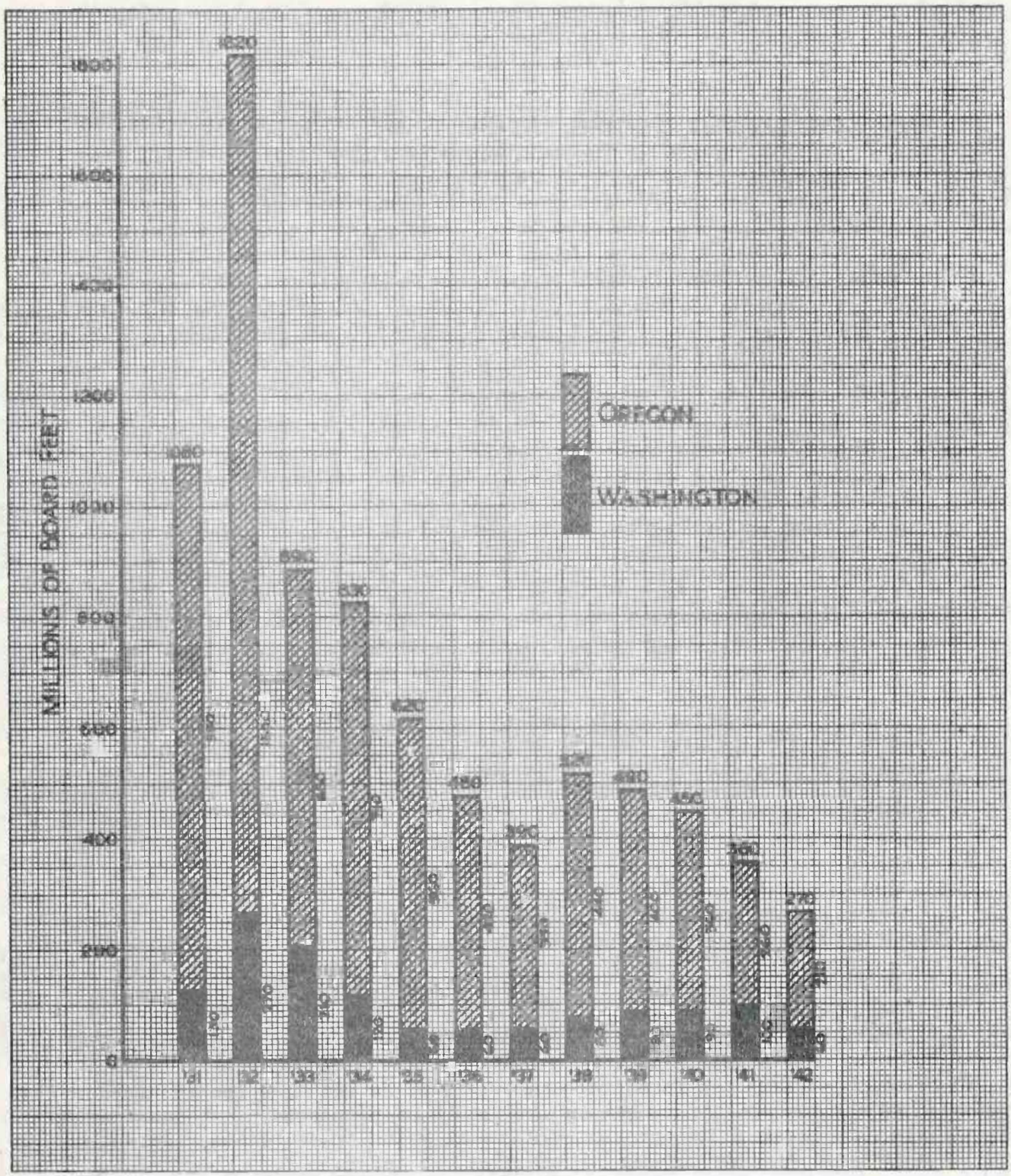

FIGURE 1. ANNUAL PINE BEETLE LOSSES IN OREGON AND WASHINGTON, 1931-1942

Ponderosa pine mortality in 1932 was the most disastrous on record. In that one year the staggering total of 1,820 million board feet of commercially valuable timber was killed by pine beetles in Oregon and Washington. In contrast with this, the loss of 270 million board feet in 1942 was the lowest on record up to that time. For the 12-year period 1931-1942, which included the peak year of 1932, gross ponderosa pine mortality caused by pine beetles averaged 683 million board feet annually.

The impetus for the epidemic that peaked in 1932 is attributed largely to two factors. First, the severe drought conditions of 1929 and 1930, occurring as they did in a prolonged period of moisture deficiency, greatly reduced tree resistance and increased the number of trees susceptible to insect attack. Second, a severe wind storm in April 1931 blew down a tremendous amount of timber throughout the region, and the pine beetles breeding in these trees spread rapidly to surrounding green timber. Had it not been for the record-breaking cold winter of 1932-1933, which destroyed from 35 to 90 percent of the overwintering western pine beetle broods, the pattern of this epidemic might have been very different. Following the beneficial effects of this freeze, there was a marked reduction of insect-caused losses during subsequent years, culminating in the low of 1942.

The decline in ponderosa pine loss may be attributed to several factors: (1) Improved moisture and growth conditions have greatly increased tree vigor and the resistance of stands to bark beetle attack; (2) fluctuations in beetle populations appear to be cyclic in character and the last few years has witnessed a downward trend, (3) cutting of mature and overmature ponderosa pine stands has been progressing at a rapid rate, particularly during the war, and the acreage of susceptible stands has been greatly reduced and will no longer support the heavy beetle damage of recent years. As a consequence of these factors it is reasonable to predict that future losses will average much lower in total volume for the region than those of the last two decades.

The losses that occurred in the years 1938 to 1942 are discussed in detail by administrative forest protective areas in a following section of this report. In addition, much statistical information relative to these losses is given in the form of tables and figures.

Relation of Losses to Growth

Forests are not static storehouses of timber, but are continually changing in both quantity and quality of usable wood. While a certain proportion of the stand is being destroyed by insects, wind, fire, and other agents, young trees are constantly growing into the stand to replace these losses. Over the long cycle, pine beetle epidemics, which take a heavy toll of the older and larger timber trees, make little difference in Nature's scheme of things, for these losses are subsequently offset by the growth of young trees which in the course of 200 to 300 years will replace the veterans which have been killed.

To the forest owner or operator who has his capital invested in a certain inventory of large-sized, high-quality, mature timber, this long cycle of recurring heavy losses balanced by subsequent growth is mainly of academic interest. His greatest concern is the short-cycle depletion of these valuable goods in storage. Whatever old-growth timber is destroyed today by beetles, fire, or other causes is a direct loss of current capital assets both in quantity and quality, if the owner contemplates harvesting this crop in the near future. If the owner lives long enough and can afford to wait until depletion from bark beetles is replaced by growth, current losses are of relatively less economic importance. But today most of the ponderosa pine forests of the Pacific Coast States are either accessible or rapidly becoming so; hence this is an inopportune time to lose the ripe mature timber now ready for harvest and badly needed for the construction of homes and for industrial development in the postwar period.

During the last two decades the ponderosa pine forests of the interior pine type have gone through a period of unusually heavy net depletion from pine beetles. On limited areas the beetles have completely wiped out the older overstory of mature timber and converted the forest into one composed entirely of young trees which are putting on growth of relatively poor quality.

For the decade 1931-1940 the total losses caused by pine beetles are estimated at 728 million board feet per year, while ponderosa pine growth is estimated at 665 million board feet per year, thus leaving a net depletion of 63 million board feet. This depletion would not be so serious were it not for the fact that much of the growth is taking place in young trees which will not reach merchantable size for several decades, or not until the current cutting cycle in the virgin pine stands is completed, while the loss from beetles is largely in trees now of merchantable size and quality.

Since 1937 beetle damage has dropped and growth rates have improved so that the growth and drain balance sheet for the region as a whole undoubtedly shows a favorable net increment. Even so, certain local areas are still badly out of balance and continue to show net depletion. Some will continue to do so until the mature stand is harvested either by loggers or by pine beetles. On many areas where growth and mortality are in balance, value depletion is continuing at a relatively high level.

Factors Affecting Losses

Pine beetle damage is not uniformly distributed over the ponderosa pine region of Oregon and Washington. In general, it is heaviest in mature and overmature stands, especially those having a high percentage of trees of declining vigor. Poor sites at the lower elevations, where moisture has been deficient, no longer show the heaviest losses because most of the susceptible timber on such areas has already been killed, and these stands are now composed largely of reproduction and young thrifty poles which are not of susceptible type. At present, losses are heaviest at the middle elevations, where stands are stagnating from too much competition for the available moisture and food supply.

In the last few years many areas previously showing heavy beetle loss have been cut over, either selectively or by clear cutting. On selectively cut areas, where the emphasis has been placed on removing trees of poor thrift rather than simply on the basis of high value, current pine beetle losses and the threat of future epidemics have been greatly reduced. These cuttings have had a marked effect in reducing the total beetle damage in the region, and in improving current growth.

The severity and extent of pine beetle depletion has also varied considerably in the different subdivisions of the pine region. The general characteristics of recent losses in these subregions are discussed in the next paragraphs.

Losses by Subregions and Administrative Protective Areas

For entomological purposes the ponderosa pine region of Oregon and Washington has been divided into four major geographic subregions. Each of these subregions has, in turn, been divided along topographic lines into divisions, areas, and units, the unit being the smallest parcel of forest land upon which pine beetle control might be recommended or conducted. All these subdivisions are of great aid in recording and interpreting beetle-caused losses but, since they do not correspond to the political and administrative subdivisions, some regrouping and discussion of the data on an administrative basis seems desirable. Therefore, both the entomological and administrative approaches are given in the discussion and the statistical data that follow.

The trend of infestation has differed somewhat in each of the four major regions (fig. 2). For example, in the Eastern Washington Subregion the upward trend of 1938 persisted through 1941, whereas in the Blue Mountain Subregion the 1938 "outbreak" was an abortive one of but a year's duration. These are comparatively minor differences which do not materially influence the basic regional trend (fig. 1). In the following discussion losses during the years 1938 to 1942 are discussed by administrative forest protective areas under the four subregions - Eastern Washington, Blue Mountains, Deschutes, and Klamath.

Eastern Washington Subregion

The Eastern Washington Subregion (fig. 3) comprises the stands of ponderosa pine in the State of Washington east of the Cascade Summit but exclusive of the northeastern portion of the Blue Mountain Range and the eastern portion of Pend Oreille County. Losses in this subregion are highly variable by areas (table 6). There also seems to be a tendency for outbreaks to develop and subside more rapidly than in other sections of the pine region. In general, western pine beetle losses during the period 1938-1942 have been endemic, although there was a definite upward trend each year from 1938 to 1941 (fig. 2).

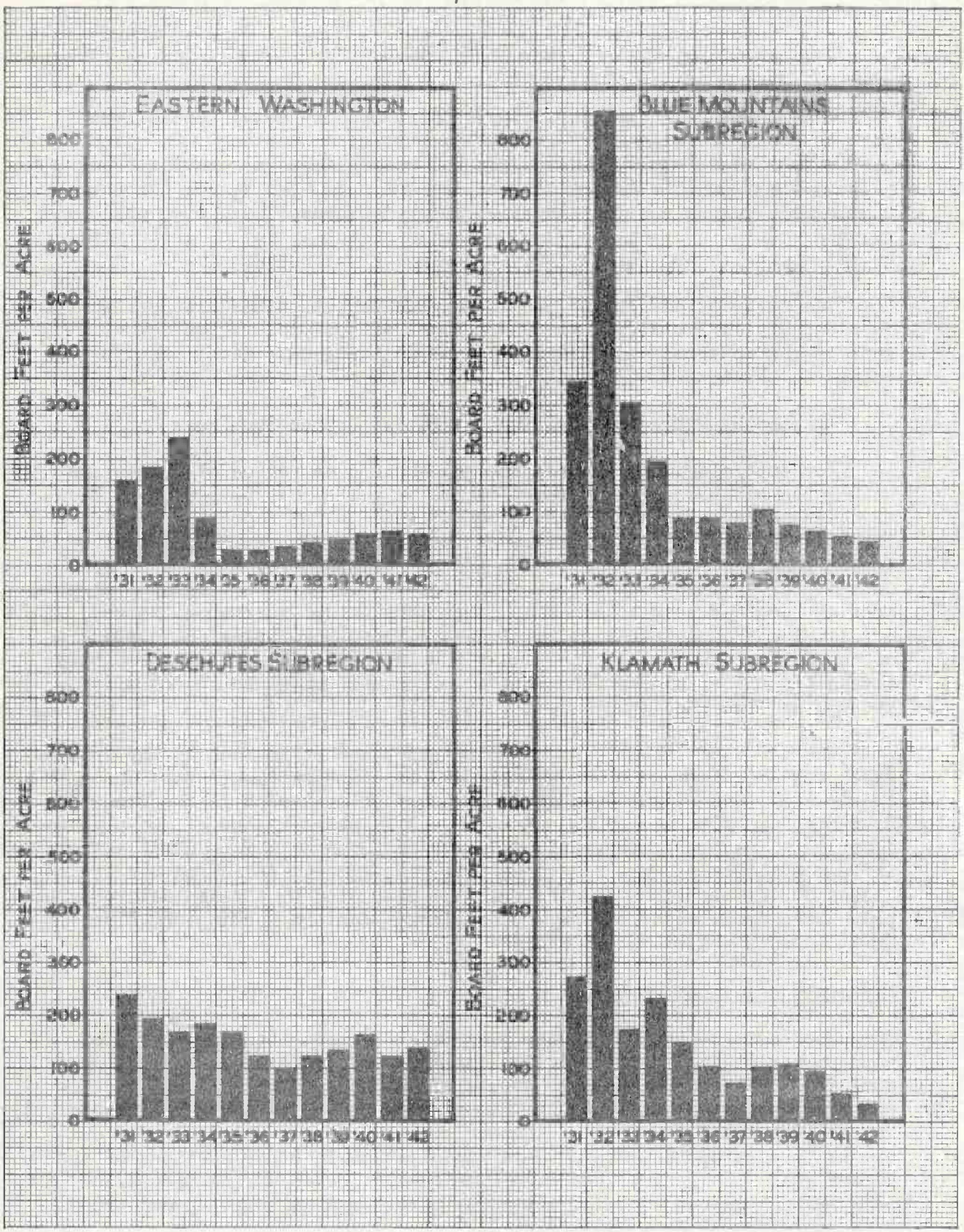

FIGURE 2. TREND OF PINE BEETLE LOSSES ON VIRGIN CHECK PLOTS, 1931-1942

National Forests

Chelan. In general, the mature pine stands of this forest contain a high percentage of trees considered to be especially susceptible to insect attacks, and yet losses due to pine beetles have been relatively light. Although no serious situation developed, losses in the years 1938 to 1942 averaged somewhat greater than growth (58, 59).* Sustained losses of this type are likely to persist, and as long as large numbers of susceptible trees remain there is the ever-present possibility of an outbreak developing. For several years cutting of privately owned timber adjacent to the forest has been progressing rapidly and, more recently, cutting on the forest has been accelerated. However, the stands within the Omak-Okanogan Timber Management Unit are being selectively logged. These activities are materially reducing current and potential losses in the fringe-type stands, where pine beetles have been most active.

Colville. Ponderosa pine is both limited in volume and scattered in distribution on this forest. Therefore, the pine beetle problem for the forest as a whole is not a serious one. Recent losses have been generally normal (60, 61), although in the largest block of pine timber on the forest that in the Lost Creek drainage moderate epidemic conditions have prevailed for several years. The stands in this drainage have been included in the Omak Okanogan Timber Management Unit and are now being selectively logged. As this logging progresses, pine beetle-caused losses are expected to become even less important.

Snoqualmie. Only a small portion of this forest lies east of the Cascade summit, but this portion contains some very fine stands of ponderosa pine. For the most part pine beetle losses have been very low and have been largely offset by annual growth. Stands in the Wenas Creek drainage have suffered the heaviest losses during the period 1938 to 1942 (83 85). Since 1940 light epidemic losses have occurred in the central part of the Tieton River drainage. A similar situation has developed on State land in the Ahtanum unit which adjoins Snoqualmie National Forest on the southeast.

Wenatchee. The demands for lumber products to supply the great fruit-packing industry of central Washington have made heavy inroads into the ponderosa pine stands both on and adjacent to this forest. Extensive logging operations have largely "beetle-proofed" the cut over lands by removing most of the insect-susceptible trees. As is usual following logging, there have been some local temporary increases of mortality due principally to exposure and injury. In spite of this tendency, losses for the years 1938 to 1942 were within normal limits (92, 93).

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* Numbers in parentheses refer to reports in Part III, p.

Indian Reservations

Colville. Over this reservation as a whole, the western pine beetle caused normal losses during the period 1938 to 1942 (100 103). However, light epidemic losses persisted in the fringe stands to the east of Nespelem, and light to medium epidemic losses were prevalent in Kartar and Coyote Creek drainages. Some of the stands on the Colville Indian Reservation have been incorporated in the Omak Okanogan Timber Management Unit. As the selective logging of these and other stands on the reservation progresses, bark beetle caused losses should become negligible. Logging is already well under way in those portions of Kartar and Coyote Creek drainages where the heaviest losses of recent years have been sustained.

Spokane. By far the larger part of this reservation has been cut over. In the remaining stands of virgin pine, western pine beetle losses are at a very low ebb, and during the period 1938 to 1942 they were more than offset by growth (100 103)

Yakima. Each year since 1936, when pine beetle infestation was extremely low, gross losses have slowly but steadily increased until in 1942 they were 2 4 times what they were at the low point These losses have not yet become serious enough to warrant resumption of direct control work under existing conditions, but sustained epidemic losses on the Dry Creek, Logy Creek, and Satus Creek units do call for attention at the earliest possible moment Selective cutting aimed at the removal of trees highly susceptible to insect attack should go a long way toward accomplish ing lasting pine beetle control Stands elsewhere on the reservation show a fairly even balance between mortality and growth (104).

State and Private Lands

Conditions on State and private holdings adjacent to the Chelan, Wenatchee, and Snoqualmie National Forests have been briefly noted in the discussion of these forests. The only other large amount of ponderosa pine in State and private ownership lies in Klickitat County. This can best be discussed under two headings, Goldendale Area and the Glenwood District. It should be noted that the Glenwood District is that part of the Klickitat River Area lying south and southwest of the Yakima Indian Reservation (fig. 3).

Goldendale Area. Infestation of ponderosa pine stands on this area has been the heaviest of any in the entire subregion for the years 1938 to 1942 (105-108). In 1940 most of the virgin stands suffered from light to heavy epidemic losses. Since then total losses have decreased markedly, both because of lessened insect activity and because the portions showing the heaviest losses have been opened up to logging. In 1942 light to moderate epidemic infestation was concentrated in the area tributary to the Goldendale-Toppenish highway. Extension of the logging operations already in progress on this area is desirable to minimize future losses.

Glenwood District. A major part of this district has been logged in such a way as to reduce losses in the reserve stands to a very low point. In virgin stands losses increased sharply in 1938 and showed a slight additional increase in 1939. Infestation then subsided until the losses in 1942 were about equal to those in 1937. Light epidemic losses persisted in the Bird Creek drainage for the entire 5 year period from 1938 to 1942. However, the progress of selective cutting is relieving this situation (109 112).

Blue Mountains Subregion

Included in the Blue Mountains Subregion (fig. 4) are the Malheur, Ochoco, Umatilla, Wallowa, and Whitman National Forests, the Umatilla Indian Reservation, and intermingled State and private timber lands. The trend of losses caused by pine beetles in this subregion (table 7) is shown in figure 2. In this figure it will be noted that from a low point in 1936 losses increased in 1937 and 1938 and then steadily decreased each year until in 1942 they were the lowest recorded over a 12 year period.

National Forests

Malheur. In 1938 and 1939 light to medium epidemic conditions were rather general on the poorer sites along the lower margin of pine growth on this forest and the adjoining private lands. Conditions improved in 1940, but losses in the virgin stands of Canyon Creek Unit and on the selectively logged areas of the Bear Valley Unit were heavy enough to warrant control measures. A combination of direct control and salvage logging was instituted in the fall of 1940 and the spring of 1941 (70). Infested trees on portions of the selectively cut areas were salvaged by the Edward Hines Lumber Company, and the U. S. Forest Service, with CCC labor, treated trees on virgin areas by the fell peel burn method. In 1941 and 1942 infestation declined to the point where there were only a few scattered areas of light epidemic infestation, none of which showed aggressive tendencies (68, 69, 71, 72).

Ochoco. The pattern of beetle infestation of the pine stands on and adjacent to this forest has closely approximated that for the entire Blue Mountains Subregion, except that on the Ochoco forest the low point was reached in 1937 rather than in 1936. A marked increase occurred in 1938, during which year epidemic losses, ranging from light to heavy, were prevalent on the Snow Mountain Area. That year moderately heavy losses occurred on the Maury Mountain Area and on the Sunflower Unit. Elsewhere light epidemic infestation was the rule on the marginal pine sites at lower elevations. In 1939 infestation declined until in 1942 it reached the lowest point since loss records were begun in 1931 (76 79).

The only direct control work done on this forest from 1938 to 1942 was on the eastern part of the Maury Mountain Area in the fall of 1939. This work is considered to have accelerated the subsequent downward course of losses on this area.

Umatilla. Ponderosa pine mortality resulting from bark beetle attacks was at a low level generally in 1937. In 1938 the trend of infestation turned sharply upward, only to decline again in 1939. Since then losses steadily decreased until in 1942 they were the lowest on record (86-88).

During this 5-year period the most serious situation was on the Fossil Area, much of which is in private ownership. From 1937 to 1939 light to medium epidemic conditions were present in most of the virgin stands of this area. In the following 3 years losses on the Kinzua Unit, the most heavily hit unit on the Fossil Area, were reduced to normal partly because of a general decline of infestation, but more especially because most of the susceptible stands were logged. With that, the last known epidemic center disappeared from the forest.

Wallowa. For several years pine beetle infestation on the Wallowa has been low to very low. Epidemic losses last occurred in 1938, during which year light epidemic infestation was present in much of the uncut timber on and near the northern part of the forest. Losses declined abruptly in 1939 and, since then, have been more than balanced by annual growth replacement (89-91).

Whitman. From a low point in 1936 pine losses on this forest increased sharply in 1937 and 1938 and then dropped back to about the same level in 1939. Instead of continuing to decline, as they did on the other forests of the Blue Mountains, losses on the Whitman forest turned upward in 1940 and 1941. Losses in 1942 decreased to the lowest point on record.

Long-continued cutting, particularly on the more accessible and marginal sites, has left a large part of the pine stands of the Whitman and the adjoining private lands relatively nonsusceptible to bark beetle attacks. Of the uncut stands, only those in the Burnt River drainage were seriously affected by beetles in the period 1938 to 1942. In 1938 moderate epidemic losses were prevalent in this drainage. Light epidemic losses were then the rule until 1942 when even these largely gave way to normal conditions (94-97).

Indian Reservations

Umatilla. The scattered pine stands of this reservation have sustained none but low endemic losses in the years 1938 to 1942. A record of these losses has been included in the reports for the Umatilla National Forest (86-88).

State and Private Lands

In the Blue Mountains there is much privately-owned ponderosa pine land, partly in large blocks but much of it scattered. In addition there are limited tracts in State and other ownerships. All these holdings are intimately associated with adjoining National Forest lands so far as entomological considerations are concerned (see discussion under individual forests). In general, however, the State and private holdings are at the lower elevations where environmental conditions are most critical and beetle-caused losses have been greatest. Extensive logging has tended to reduce the losses in recent years.

Deschutes Subregion

The Deschutes Subregion (fig. 5) includes the Deschutes and Mount Hood National Forests, the Warm Springs Indian Reservation, and large private holdings, most of which are adjacent to the Deschutes National Forest. Pine mortality resulting from bark beetle attacks has varied widely in different parts of this subregion. On some areas most of the mature pine has been killed; on other areas relatively few trees have succumbed to the beetles. Losses continued variable in the years 1938 to 1942 (table 8), with heavy losses on the slopes of the Cascades to the north of Bend and moderately light losses in stands to the south of Bend.

During the 12 years from 1931 to 1942 the trend of infestation in the Deschutes Subregion (fig. 2) most closely approximated that of the adjoining Klamath Subregion. However, losses differed from those in the Klamath and the other two subregions by being less severe in 1932, by declining less rapidly thereafter, and in general by showing less variation from year to year.

National Forests

Deschutes. The ponderosa pine stands on this forest and the adjacent private land showed varying intensities of pine beetle damage. On the Sisters Area gross losses increased to the extent that in 1942 they were approximately double the low of 1937. This increase was despite extensive cutting on private land where losses were greatest. In the winters of 1939-40 and 1940 41, direct control was undertaken on 65,000 acres in the heart of the Sisters infestation area and seems to have been a factor contributing to the temporary arresting of the upward course of infestation in 1941. In 1938 epidemic losses were occurring in rather extensive stands of high beetle hazard on the Fort Rock Area, but since then most of these stands have been selectively cut and now they show only very light losses. In the upper Deschutes Basin between the Paulina Mountains and the Cascade Range, losses continued to be less than current growth (62,64).

Mount Hood. There are few ponderosa pine stands in the Pacific Northwest that have been so seriously depleted of mature pine timber by pine beetles as have the stands on the east side of the Mount Hood National Forest. The beetles exacted an average toll of 7.2 percent of the stand in the years 1938 to 1942, and on the most heavily infested areas the loss was nearly twice as great. Infestation increased about 200 percent from 1937 to 1940, decreased considerably in 1941, and increased again in 1942 (73-75).

Indian Reservations

Warm Springs. In the years 1938 to 1942 the pine stands of this reservation, together with the adjoining stands of the Deschutes and Mount Hood National Forests, were more heavily hit by pine beetles than any other extensive stands in Oregon or Washington. Losses on the reservations remained high, with an upward tendency, except in 1941 (103).

The most ambitious program ever undertaken to control the western pine beetle by direct methods was carried out on this reservation from 1933 to 1940. A total of 51,751 infested trees were treated by the fell-peel-burn method and, as a result, substantial stands of mature pine were saved from beetle destruction. This large-scale practical test is also of great value in indicating the limitations of direct control measures so long as a large number of susceptible trees are present and conditions remain favorable for beetle development. Such measures are a temporary and costly expedient. A much more satisfactory method is to reduce losses through removal of the most susceptible trees. Light selective cuttings to attain this end were planned for 1943 on the Schoolie Unit.

State and Private Lands

For the most part the extensive stands of privately-owned ponderosa pine and the scattered holdings by the State in this subregion are intimately tied in with the Deschutes National Forest. Much of the privately-owned land is being selectively logged on an exchange basis. On the lands so logged current losses resulting from bark beetle attacks are very low. On the unlogged portions of the Sisters Area epidemic losses were prevalent during the 5 year period 1938 to 1942 (62-64).

Klamath Subregion

The Klamath Subregion (fig. 5) includes the Fremont and Rogue River National Forest, the Klamath Indian Reservation, and large areas of privately-owned ponderosa pine adjacent to and intermingled with these federally owned lands. Most of these private areas are protected by the Klamath Forest Protective Association. There is a long history of pine beetle control operations in this subregion dating back to 1911 and the first attempts of the Klamath Lake Counties Forest Fire Association to control the western pine beetle on privately owned lands. Since then four pine beetle epidemics of approximately 7 years each have swept through these virgin ponderosa pine forests, taking a heavy toll of commercially valuable timber (56). The most recent epidemic started in 1938, increased to a fairly high level in 1940, and then dropped to a new low in 1942 (table 8). This epidemic was much less severe than any of the three preceding infestations. The general trend of recent losses in this subregion is shown in figure 2.

National Forests

Fremont. During the period 1938 to 1942 pine beetle damage continued to be severe on portions of this forest and the adjoining private land; particularly on the Bly, Silver Lake, and Chewaucan Areas. In general, however, the losses were greatly reduced over those of the previous decade. In the fall of 1941 direct control operations on the Chewaucan Area were undertaken by the Forest Service and the Klamath Forest Protective Association, following a summer of heavy losses and large group formation. A marked decline in the infestation occurred throughout the forest in 1941. This trend continued in 1942 so that no further direct control work was needed (65-67).

Rogue River. The larger part of the privately owned timber lands adjacent to this forest has now been cut, and there is little virgin ponderosa pine left which is susceptible to beetle damage. As a result pine beetle losses have been extremely low on and near this forest since 1938, and no further loss of any consequence is anticipated in the immediate future (80, 81).

Indian Reservations

Klamath. Pine losses on the Klamath Indian Reservation during the period 1938 to 1942 closely approximated the general trend in the Klamath Subregion (fig. 2). From a low point in 1937 infestation increased to a high in 1940 and then subsided until, in 1942, losses caused by pine beetles were the lowest in 21 years (99).

During recent years the Office of Indian Affairs greatly expanded its cutting program in order to alleviate the wasteful depletion caused by insects. Many of the susceptible stands have now been selectively cut, and the residual stands are in a very vigorous and insect resistant condition. Since not all the stands that were in need of attention could be cut at once, it became necessary to do some direct control work. This work was done in the winters of 1937-38 and 1938-39 under the CCC program.

State and Private Lands

The most extensive stands of privately owned ponderosa pine timber in the Pacific Northwest are in the Klamath Subregion. In contrast, State owned lands are few and scattered. On the Keno Area, which lies to the east and south of the Rogue River National Forest, most of the virgin pine in private ownership has been cut, and the remainder is in prospect of early cutting (80,81). To the east of Klamath Falls logging operations have also largely covered the Bonanza and Bly Areas, which in years past were heavily depleted by pine beetles (65, 67). In the uncut stands of privately owned pine in the Klamath Subregion, pine beetle infestation during the years 1938 to 1942 followed the general pattern for the entire subregion (fig. 2).

Control Program

Ponderosa pine depletion by pine beetles remains a major thorn in the side of timber owners in the pine region. For many years both Federal and private owners have carried on an extensive and costly direct control campaign designed to protect timber resources from pine beetle attacks. So long as climatic conditions remained favorable for the beetles there could be no safe let-up in this control program, but increased rainfall in the last few years has improved tree vigor, which in turn has caused a decrease in beetle population. Consequently, since 1941 there has been less need for direct control measures.

In recent years there has been a marked trend toward substituting indirect for direct control methods. This change has been brought about by several factors. First of all, investigations have provided a promising solution to the pine beetle problem by the application of indirect control through the removal of susceptible types of trees. New logging methods, a steadily decreasing supply of mature pine, and the opening up of previously inaccessible areas have all influenced the trend toward indirect control.

Control, both direct and indirect, for the years 1938 to 1942 is discussed in the following paragraphs:

Surveys

Annual detection surveys (53-57) continued to be the backbone of the pine beetle control program by yielding information on where and to what degree losses occurred. The Forest Service, the Office of Indian Affairs, and private timber owners contributed funds and personnel for much of the field work. As in past years, the Portland Forest Insect Laboratory outlined the general survey program, gave technical supervision to the field work, and assembled and distributed data in the form of loss reports. (Reports for the Klamath, Warm Springs, and Yakima Indian Reservations before 1942 were prepared by Harold Weaver of the Office of Indian Affairs).

These surveys are of two general types, intensive check plot surveys and extensive or observational surveys. Intensive surveys are made by seasonally recruited three-man crews, which check the annual mortality that occurs on numerous 320 acre plots scattered throughout the pine region. The information thus obtained is important in showing the rise and fall of beetle infestation from year to year and also in providing a yardstick for the preparation of estimates of losses on administrative areas. Tables 1 to 5 show the annual losses actually marked on check plots during the years 1938 to 1942. For convenience, these data are arranged by administrative and protective subdivisions.

Extensive surveys are made by experienced entomologists, who attempt by visual methods to estimate total annual pine mortality in all the more important pine stands of the region. Actual losses recorded on the 320-acre plots are used as a guide in making these general estimates, which are the basis for the generalized loss figures given in tables 6 to 9. During the war the extensive surveys were conducted on a much reduced scale, and, consequently, more reliance was placed upon the sample plot data as a gage of regional losses.

Direct Control

Although western pine beetle losses throughout the ponderosa pine region of Oregon and Washington during the period 1938 to 1942 were generally only slightly above normal, the surveys revealed several localized centers of infestation that warranted control measures. Control by the fell-peel-burn method was undertaken in these "hot spots" in order to minimize the danger of continued losses. Tables 10 to 13 summarize the several control projects from the fall of 1938 through the spring of 1941. No direct control work was done in 1942.

On National Forests. During the period 1938 to 1942, the Forest Service conducted eight control projects in which 11,406 trees were treated at a cost of $50,129. These projects were located on the Fremont, Deschutes, Ochoco, and Malheur National Forests. The work on the Deschutes and Malheur was done in connection with the CCC program, while the other work was done as a part of regular activities.

On Indian Reservations. The Office of Indian Affairs conducted control work against the western pine beetle on the Warm Springs Indian Reservation continuously from 1933 to 1941. On the Klamath Indian Reservation the most recent control work was conducted during the winter of 1938-1939. None has been carried out on the Yakima Reservation since 1936. During the period 1938 to 1942 a total of 16,432 trees were treated at a total cost of $81,017; most of these trees were on the Warm Springs Reservation.

On Private Lands. Direct control work on private lands has been confined to that undertaken by the Klamath Forest Protective Association largely on lands of the Weyerhaeuser Timber Company in the vicinity of Klamath Falls, Oreg. During the period 1939 to 1942 the Association expended $18,653 in treating 6,062 trees.

Indirect Control

Partial cutting of ponderosa pine stands to remove trees most susceptible to beetle attack has proved to be a very promising method of indirect pine beetle control (5). This method is directed toward prevention or avoidance of loss, rather than direct elimination of beetle populations.

In general any selective cutting by which the more susceptible types of trees are removed is effective in reducing bark beetle losses in ponderosa pine stands. Present marking practice in wide use on the National Forests and Indian Reservations in Oregon and Washington includes most of the more susceptible trees, and the effectiveness of removing such trees is evident in the low losses currently found in the reserve stands.

A more recent development is so-called sanitation-salvage or pine beetle control logging (37-41), in which only the trees most likely to succumb to beetle attack within 5 to 10 years or so are removed (usually 15 to 20 percent of the stand). Sanitation-salvage logging was first started on an experimental basis in California in 1937. In 1940 it was initiated in Oregon by the Weyerhaeuser Timber Company, which set aside a 1000-acre experimental tract in Klamath County for this purpose. High-risk trees averaging about 1000 board feet per acre were removed from this tract by a contract logger at a cost only slightly higher than normal logging costs. The entire operation was carried out at a profit. Because this first test showed such promising results, another large experimental area of about 6000 acres was similarly treated in 1941, and slightly over 5 million board feet of high-quality high-risk timber was removed. These two experiments are furnishing very valuable data on the effectiveness of this method and its economic aspects.

In 1943 only 3 years' complete data were available concerning the results of the experiment on the 1000-acre tract, but these results were very encouraging. It was found that the infestation on the selectively logged area had been reduced 94.1 percent the first year, 73.2 percent the second year, and 72.1 percent the third year, as compared with losses on neighboring untreated areas. The larger experimental cutting provides data for only a 2-year period. In the first 2 years losses on the selectively logged area were 90.0 and 93.2 percent less than the loss trend on uncut areas. These results indicate that the direct loss from pine beetle attack can be largely prevented, and possibly even turned into a profit, through the salvage of high quality timber that would otherwise be lost through attacks by the western pine beetle.

Although final results will not be available for some time, these first results are sufficiently positive to warrant further testing of this method by other interested operators. The next few years appear to be particularly advantageous for this work, both from the standpoint of lumber markets and pine beetle infestation. Assistance in training of crews in the recognition of susceptible trees can be secured through this office.

Research Program

The Forest Insect Laboratory at Portland, Oreg. is primarily responsible for the investigation of methods for controlling forest insects in Oregon and Washington. Because of limited funds it has been necessary to concentrate largely upon the pine beetle problem, which has long been the preeminent one in these States. A brief discussion of recent accomplishments on the research projects relating to this major problem is given in the following paragraphs.

Surveys

A major portion of the funds has been used for annual surveys of ponderosa pine stands conducted cooperatively with Federal forest agencies and private timber owners. These surveys have a dual purpose (1) to provide reliable information upon which to base control, and (2) to provide a long-time continuous record of loss that is basic to determining the factors underlying pine beetle outbreaks. The areas surveyed and the control projects that were recommended and carried out as a result of the surveys have already been discussed.

Natural Control Factors

Investigation of the role of natural factors in the rise and fall of pine beetle epidemics has been in progress for many years. A full understanding of how these factors work would be an invaluable aid in predicting trends of beetle losses, a reliable forecast of which is essential to well-ordered artificial control programs.

Low temperatures

Each winter from 1937 to 1942 minimum temperatures on selected check plots in the ponderosa pine region were recorded in an effort to correlate temperatures in the woods with temperatures at standard weather stations during periods of cold weather. Previously the effects of known low temperatures upon pine beetle broods was determined. This study is providing information (16) that is necessary to determine whether going control projects should be completed or discontinued after unusually low temperatures occur.

Silvicultural Control

Tree selection

One of the important results of the ponderosa pine research program has been the development of a system of classifying trees according to their age and vigor. This system has found wide usage in ths region and has been modified for use in other pine-growing States. To provide more exact limits of demarcation between the tree classes, and thus reduce the chance of varying standards of interpretation, a revision (4) of some of the original descriptions was necessary. This revision was based on a statistical analysis (32) of the external tree characters and growth rates of about 7,000 ponderosa pines on thirty 10-acre plots scattered through the commercial forested areas of eastern Oregon.

As a biproduct of this study a pocket slide rule (25) for determining the tree classes has been developed. This rule has proved helpful in standardizing interpretation of the tree classes and, to a large extent, eliminates personal adjustment in classifying trees.

Sanitation-Salvage Logging

From the standpoint of controlling depredations of the western pine beetle, the most important recent development is the large-scale testing of sanitation-salvage logging, which has been discussed under Indirect Control (see page 16). This type of light selection (usually 15 to 20 percent cut) is considered adaptable to upward of 2 million acres of ponderosa pine in Oregon and Washington. Considerable additional research work is needed to perfect this method of control, which has shown such promising results in the tests conducted so far.

Area-Hazard Zonation

An outstanding characteristic of insect-caused losses in ponderosa pine stands is their uneven distribution. Detailed plot data have shown that certain factors are associated with and help to explain this variable loss from bark beetles in different parts of the ponderosa pine forests. Among the factors found to be significant in this respect are past losses, percentage of high-risk trees, stand volume per acre, growth reduction, and amount of competing vegetation. Several other factors are suspected of being important (32).

With the information at hand, preliminary analyses were made of the pine beetle hazards in the Klamath Subregion (27-30) and in the Upper Deschutes Basin (31). All pine stands on these areas were rated according to degree of anticipated losses resulting from bark beetle attacks. Five broad classes of hazard were recognized, as follows - very low, low, medium, high, and very high. Maps showing the area distribution of these classes were then prepared and distributed. These maps should be of value to timber owners who wish to reduce losses by logging first those pine stands that are most likely to be depleted by beetles.

PART II. OTHER INSECT PROBLEMS

The following discussion of forest-insect problems, other than the western pine beetle problem, is arranged by species of insect under three main headings: (1) Insects attacking forest trees, (2) insects attacking shade trees, and (3) insects attacking wood products. Only the more important species are mentioned and, of necessity, the records are based upon information available at the Portland Forest Insect Laboratory. Outbreaks that occurred during the period 1938 to 1942, habits of the insects, control projects and methods, and results of investigational work are discussed.

Insects Attacking Forest Trees

Cambium Miners

Mountain Pine Beetle (Dendroctonus monticolae Hopk.). During the period 1938 through 1942 aggressive activity of the mountain pine beetle was noted only in the Cascade Mountains of Oregon and Washington. In Washington the most extensive infestation was in the white pine stands of the eastern part of Mount Rainier National Park (35, 98) and in the adjoining part of Snoqualmie National Forest. An outbreak that began sometime prior to 1935 continued to take a heavy toll of white pine on the recreational area lying between Spirit Lake and Mt. St. Helens. Scattered group killing of white pine along the headwaters of Lewis River persisted. In 1942 an extensive outbreak was noted in lodgepole pine in the vicinity of Colockum Pass between Ellensburg and Wenatchee. In Oregon the only notable infestation by the mountain pine beetle was on the Olallie Lake Recreational Area of the Mount Hood National Forest and the nearby Warm Springs Indian Reservation. Over a period of several years most of the mature lodgepole was killed on about 12 sections of the most heavily affected area. In all perhaps a township sustained loss, including some killing of white pine. The lodgepole pine stands of Crater Lake National Park and the Diamond Lake Recreational Area of the Rogue River National Forest that were so heavily infested in the early 30's have shown almost no mountain pine beetle activity during the past 5 years.

Control work was done only in Mount Rainier National Park. There the National Park Service, through an annual maintenance control program, kept the mountain pine beetle well in check on the protected units until 1940 (35). During 1940 and 1941 there was a sudden increase of killing in the untreated low-use areas, and considerable infiltration from them into the treated areas, which are in the important recreational centers. Suppression of this flare-up was hampered by a labor shortage brought about by the war and the consequent discontinuance of the CCC program. What the ultimate effects of this curtailment of control work would be, was yet to be determined in 1942.

Mountain pine beetle infestation in ponderosa pine and sugar pine stands continued as a minor factor, causing some loss of these tree species.

Douglas-Fir Beetle (Dendroctonus pseudotsugae Hopk.). Sporadic outbreaks of the Douglas-fir beetle (43) are fairly common in the Pacific Coast region. Such outbreaks are usually brought about by some disruptive influence affecting the stand, such as fire, wind, and logging. It is especially characteristic for the beetle to multiply in fire-killed and fire weakened trees and later to emerge and attack green timber nearby. Severe local damage may result, but infestations subside so rapidly from natural causes that artificial control measures are seldom feasible.

The outbreak that from 1934 to 1937 killed about 200 million board feet of Douglas fir adjacent to the Tillamook Burn dropped out of the picture completely by 1938. No further Douglas fir beetle activity was observed on this area.

Widespread group killing of Douglas fir occurred along the coastal area of central and southern Oregon in 1938 and 1939. This outbreak, which was presumed to have developed in trees that were killed by the disastrous fires of 1936, subsided in 1940.

In 1940 and 1941 moderate group killing occurred on the White River Recreational Area of Snoqualmie National Forest (82). No comprehensive control program was undertaken, but many of the more accessible infested trees were utilized in 1941. This may have contributed to the cessation of activity in 1942.

Oregon pine engraver (Ips oregoni (Eichh.)). Killing of ponderosa pine reproduction by the Oregon pine engraver increased in the Blue Mountains during 1938. This killing was associated with logging operations on the western part of the Ochoco National Forest and to a lesser extent on the Burnt River Area of the Whitman National Forest. Infestation increased to a high level in 1939 and 1940 and then, coincident with abnormally abundant spring and summer rains, the outbreak declined markedly in 1941. Where group killing was so excessive as to cause understocking of the reserve stand, the outbreak was harmful. To the extent that stagnated reproduction was released from competition, the results were beneficial. The over-all importance of Ips in the management of ponderosa pine stands remains to be worked out, but it is likely that these insects will be of increasing importance under intensive management.

A study (34) in 1940 and 1941 showed that 91.3 percent of the Ips-killed trees were on or near areas logged between February 1 and June 30, whereas only 8.7 percent were on areas cut during the remaining 7 months. The implications are that July through January is a relatively safe time to carry on improvement cuttings or other operations where it is desirable to avoid extensive killing of reserve trees by Ips.

Fir engraver (Scolytus ventralis Lec.). The fir engraver is the principal one of several species of Scolytus that attack true firs in the Pacific Northwest. Although it normally causes rather high mortality of the host trees, it is not of great economic importance because of their relatively low value. This bark beetle maintains a sizable part of its population in living trees, a habit that so far has defied efforts at developing practical control measures.

Generally speaking, damage by the fir engraver was normal or somewhat below during the period 1938 to 1942. Most notable exception was the heavy killing of white fir on the Wallowa and Whitman National Forests in 1938 and 1939. In the centers of heaviest infestation, as around Fairchild Lookout on the Wallowa, 10 to 15 percent of the fir was killed in the years from about 1937 to 1939. Infestation subsided in 1940. A local flare-up in the vicinity of Fort Simcoe on the Yakima Indian Reservation was reported in 1940. Apparently no extensive killing developed in that area.

Douglas-fir twig weevil (Cylindrocopturus furnissi Buch.). In recent years the Douglas-fir twig weevil (7) has been found to commonly infest Douglas fir reproduction in western Oregon and Washington. Small trees growing under drought conditions are often severely stunted or even killed. During the extremely dry summer of 1938 this weevil, together with several other insects of lesser importance, caused considerable damage to drought-weakened trees growing on gravelly sites in the Puget Sound Basin of Washington. In the succeeding year infestation dropped back to normal.

Defoliators

Hemlock looper (Lambdina fiscellaria lugubrosa (Hulst)). A heavy flight of adults of the hemlock looper occurred along the south fork of the Stillaguamish River on the Mount Baker National Forest, Washington, in October 1938. The source of this flight has never been definitely determined. In the summer of 1943 a hemlock "kill" of several years' standing was observed on the Day Lake area of the Skagit River drainage. This kill, according to local report, was caused by the hemlock looper, and it may have been the unaccounted source of the flight in the fall of 1938.

Douglas-fir tussock moth (Hemerocampa pseudotsugata McD.). An outbreak of the Douglas-fir tussock moth was reported (69) as defoliating an extensive stand of true fir and Douglas fir on the Rudio Mountain unit of the Malheur National Forest, Oreg., in August 1938. This outbreak greatly increased in 1939 and, as a result, approximately a third of the trees died on the area of heaviest defoliation. During the summer of 1939 some undetermined factor caused heavy mortality among the large larvae. Consequently, the 1939-40 generation was very light and caused no noticeable defoliation in 1940.

Another, but less severe, outbreak of the Douglas-fir tussock moth was discover d in 1939 near Spray, Oreg., on the Umatilla National Forest. This infestation, which also disappeared in 1940, is not known to have killed any appreciable number of the attacked trees.

Spruce budworm (Archips fumiferana (Clem.)). This destructive defoliator has been present in Oregon for at least 30 years, and it may even be native to the region. Rather curiously, it has seldom been reported in numbers and apparently has caused little damage in the Pacific Northwest. In 1941 white fir and lodgepole pine in the Warner Mountains of the Fremont National Forest, Oreg., were heavily defoliated by the spruce budworm (65). Infestation continued in 1942. The ultimate effects of this outbreak are yet to be determined.

Silver-spotted halisidota (Halisidota argentata Pack.). The silver-spotted halisidota became abnormally abundant during 1937 along the Washington and Oregon coast and continued to be present in large numbers during 1938. Feeding was prevalent on Douglas fir, Sitka spruce, and lodgepole pine, but no killing or serious weakening of infested trees was observed. Infestation declined in 1939 and since then has continued at a normal level.

Tent caterpillars (Malacosoma spp.) appear in epidemic numbers somewhere in Oregon or Washington nearly every year. They are of minor economic importance in this region.

Oak tent caterpillar (Malacosoma constricta (Stretch)). Kellogg and Garry oaks in the Rogue River Valley, Oreg., were moderately defoliated by this insect in 1939.

Forest tent caterpillar (Malacosoma disstria Hbn.). The forest tent caterpillar was reported as abundant on native cottonwoods near the head of Lake Chelan, Washington, on willows in Coos County, Oreg., and along the lower Columbia River, and on fruit and ornamental trees in the vicinity of Portland---all during 1939. These outbreaks continued in 1940 and declined in 1941.

Great Basin tent caterpillar (Malacosoma fragilis (Stretch)). An outbreak of the Great Basin tent caterpillar developed on bitterbrush on the Cabin Lake area of the Deschutes National Forest, Oreg., in 1937. Infestation of this important range plant increased greatly in 1938, and became widely epidemic in 1939, when 100 percent defoliation was general on two grazing allotments that were most heavily infested. The outbreak was controlled by natural factors in 1940. That year a widespread, but less severe, infestation occurred on bitterbrush in lodgepole pine stands further south in the Klamath Marsh area. Defoliation in this vicinity decreased somewhat during 1941 and 1942.

Western tent caterpillar (Malacosoma pluvialis (Dyar)). In 1939 the western tent caterpillar was extremely abundant on red alder in the Puget Sound Basin of Washington and moderately abundant on the same host along the Oregon coast. These outbreaks continued at about the same intensity during 1940, but declined in 1941.

Sawfly (Neodiprion sp.) An undetermined species of Neodiprion was first noted in 1941 to be defoliating lodgepole pine in the northern part of Klamath Indian Reservation, Oreg. In 1942 infestation had spread until it covered nearly a township. A few small trees in openings have been killed, but most of the affected trees are expected to survive, for the sawfly larvae usually leave most of the current year's foliage. In common with most defoliators, this sawfly is heavily attacked by parasites, and consequently the outbreak is expected to subside within a short time.

Sucking Insects, Scales, Aphids, etc.

Spruce aphid (Aphis abietina Wlk.) A general outbreak of the spruce aphid developed on Sitka spruce along the Oregon and Washington coast in 1941. Many trees were severely defoliated, and some of the weaker ones died. The year 1941 was the first time since 1931 that the spruce aphid was observed to be epidemic on forest trees. Presumably the outbreak subsided in 1942.

Balsam woolly aphid (Chermes piceae Ratz.). In Oregon the balsam woolly aphid was first found in 1937 on lowland white fir (Abies grandis) near Salem. During 1941 heavy infestations were found in stands of lowland white fir along the Willamette River at Corvallis, Wilsonville, and Portland. Some of the firs in these heavily infested areas died. It is likely that the balsam woolly aphid was largely responsible for this mortality, for this insect seriously weakens trees by feeding upon the bole and larger branches and also by causing "gouty" deformities of the buds (52).

Pine stem scale (Matsucoccus bisetosus Morrison). This scale was reported in 1938 as heavily infesting a 30 to 60 year old stand of ponderosa pine on about 400 acres of the Burns ranger district of the Malheur National Forest, Oreg. Infestation over a period of years had caused wholesale deformity of the boles and branches of the affected trees. Even though M. bisetosus is widely distributed in the pine stands of Oregon and Washington, this is the first report of any considerable damage from its attacks.

Pine needle mite (Phytoptus pini Nalepa). In 1941 damage caused by this eriophyid mite was found in a plantation of ponderosa pine at Thorn Prairie, Umpqua National Forest, Oreg. Yellowing and shortening of the needles on the terminal half of the 1941 growth was associated with and seemed attributable to a heavy population of the pine needle mite. This is the first record of this type of injury to pine in the Pacific Northwest.

Insects Attacking Shade Trees

Numerous insects infest shade and ornamental trees in the Pacific Northwest, but only a few cause damage of a serious nature. During the period 1938 to 1942 there were no widespread outbreaks.

Cypress leaf miner (Argyresthia cupressella Wlsm.) This very small moth seriously infests ornamental cypress (Cupressus). It also infests Thuja and Chamaecyparis, but to a much lesser degree. The tiny larvae mine in the leaves and, when abundant, cause nearly complete defoliation. Infestation was especially prevalent in 1938 in the vicinity of Portland. Because of the unsightly appearance of attacked trees and because of the difficulty in controlling the insect, numerous home owners have taken out their ornamental cypresses and replaced them with other evergreens.

Satin moth (Stilpnotia salicis (L.)). This European species, a serious defoliator of poplars and willows, was first noted in Washington in 1922 and in Oregon in 1934. It is well established from the Canadian border to Linn County in Oregon west of the Cascade Range. For several years the satin moth was troublesome on ornamental Carolina, Lombardy, and white poplars and also on heavily defoliated stands of native cottonwoods and willows. In 1935 the satin moth population began to decrease and by 1938 had reached a low level. Infestation remained light through 1942. Several European parasites of the moth have been successfully introduced into the Northwest and may be responsible for holding it in check.

Elm leaf beetle (Galerucella xanthomelaena (Schr.)). Another native of Europe, this species has become firmly established on ornamental elms in the Pacific Coast States. In Portland, for example, it is necessary for the city park bureau to conduct an annual spray program in order to keep the beetle under control. An effort in 1941 to introduce a parasitic fly, Erynnia nitida R.D., from California was not successful.

Insects Attacking Wood Products

Attacks of insects upon wood products, long a source of loss and annoyance, have assumed increased importance now that repair or replacement of the damaged or destroyed articles is so costly. Most of the insects that cause this type of damage fluctuate in numbers very little from year to year; hence efforts to keep them under control must be sustained. In most instances control is a matter of individual concern. A detailed record kept from year to year shows the following insects to be the more important ones that attack products made of wood (9-12).

Carpenter ants (Camponotus spp.) These large black ants probably cause more damage to wooden buildings in the Pacific Northwest than any other insects. Carpenter ants seldom cause great damage in individual cases, but because of their abundance, they exact an imposing regional toll from home owners. From year to year there is no measurable difference in the amount of infestation. In the period 1938 to 1942, for example, there was no evidence that the number of ant infested houses had either increased or decreased.

Studies (50) conducted over a period of years in Oregon and Washington have shown that control is difficult and that no one method, so far known, will give control under all conditions. Three principal measures are recommended for keeping carpenter ants in check upon individual properties. (1) All colonies in stumps, logs, waste wood, etc., near houses should be destroyed to prevent migration of the ants. (2) Wherever feasible, colonies in houses should be completely exposed and all the ants killed with a contact insecticide such as fly spray. (3) Where exposing the ants is impractical, sodium fluoride or rotenone (4 percent) dust applied in the galleries and runways is usually effective.

Termites

Termites have not yet become especially destructive in Oregon or Washington. Much of the damage attributed to them is caused by other insects, especially carpenter ants. Very largely, the methods of prevention and control developed in other parts of the country are applicable to the Pacific Northwest. It should be kept in mind, however, that there is less need for elaborate preventive measures than in certain other areas where termites are more destructive.

Common damp-wood termite (Zootermopsis angusticollis (Hagen)). Although the damp wood termite is extremely abundant, it causes little primary injury to houses and other wooden structures, for it mines principally in wood that is already rotten. Elimination of the conditions favoring development of rot is usually sufficient to control the damp-wood termite and prevent further infestation.

Western subterranean termite (Reticulitermes hesperus Banks). The subterranean termite is widely distributed in both States and is potentially a serious threat to wooden buildings, but as yet it has been recorded as causing only occasional damage. Apparently it has been kept in check by natural factors. There are indications, however, that the amount of damage is slowly increasing. It is likely that this increase will be accelerated by the practice of constructing extremely low houses without basements and without adequate clearance.

Powder-Post Beetles

Several species of powder-post beetles cause damage to hardwood products such as furniture, flooring, tool handles, and novelties. Damage by this group of insects, but more especially damage by Lyctus to oak flooring, has shown a marked increase in recent years. Apparently most, if not all, of the trouble caused by Lyctus has come from infested wood shipped in from other parts of the country. Control may be obtained by repeated surface applications of turpentine and kerosene (9:1) or undiluted orthodichlorobenzene.

Hadrobregmus gibbicollis (Lec.), which is native to the Pacific Northwest, is of particular interest in that it attacks both hardwoods and conifers (48). Recent reports indicate that buildings along the coastal belt in Oregon and Washington are often damaged by the larvae of this beetle. Very little is known of its habits and control.

Buprestids

Two buprestids, Buprestis aurulenta L. and B. langi Mann., commonly damage various Douglas fir products (49). Both species can and do attack wood, both before and after it has been seasoned and put in place. Infestation is widely prevalent, but damage to houses is usually confined to the weakening or disfigurement of only a few boards or timbers, and even this occurs over a period of years. Under circumstances where wood is kept moist and remains subject to repeated attacks, as in the case of wooden tanks, the damage caused by Buprestis larvae is a matter of importance. Investigations of control are under way, but no practical measures have yet been devised.

Ambrosia Beetles or Pinhole Borers

These small beetles degrade spruce, hemlock, and fir logs that have been left in the woods for a considerable time, particularly during the heavy flight period of the beetles in the spring. It was thought that this damage might be of increased importance in connection with the production of airplane stock during the war. However, it developed that logs were removed from the woods so rapidly that no appreciable ambrosia beetle damage was caused.

Insects in Fire-killed Douglas Fir

From time to time large fires, such as the Tillamook fire of 1933, kill extensive stands of Douglas fir timber in the area west of the Cascade Range. Practically all the timber killed in this manner is salvageable immediately following fire, but because of the inroads of insects (6) and fungi its marketability gradually decreases over a period of years. No practical way of halting the progress of these deteriorating agents has been found. About the best that can be done is to increase total salvage by logging first the timber that will be deteriorated first. In this connection it has been found that small size, rapid growth, thick sapwood, and nearness to old burns are factors associated with rapid deterioration. Conversely, large size, slow growth, thin sapwood, and remoteness from old burns are associated with slow deterioration (46, 47).

On the Tillamook burn salvage dropped off markedly by 1939, chiefly because of prevalent degrade caused by two roundheaded borers, Criocephalus productus Lec. and Asemum atrum Esch. Then salvage picked up in response to a heavy demand for low-grade lumber, first for defense activities and later for war purposes. Some of the resulting lumber went into the construction of houses. Often such lumber contained Criocephalus and Asemum larvae which subsequently developed into beetles and emerged through finished wood, thereby causing considerable concern to home owners but little material damage to the dwellings.

PART III. APPENDIX OF STATISTICAL INFORMATION AND REFERENCES

Table 1. Summary of Gross Losses of Ponderosa Pine on Virgin Check Plots, Season of 1938.

Administrative Areas	Check Plots: Timbered Pine: No.	Check Plots: Timbered Pine: Acres Cruised	Check Plots: Timbered Pine: Volume M Bd.Ft.	Ponderosa Pine Losses: Trees	Ponderosa Pine Losses: Volume Board Feet	Ponderosa Pine Losses: % of Stand	Ponderosa Pine Losses: Bd. Ft. per Acre
OREGON							
NATIONAL FORESTS							
Deschutes	21	6,110	96,745	769	580,265	.60	88
Fremont	14	4,435	61,302	620	458,975	.75	104
Malheur	15	4,720	66,520	618	459,635	.69	98
Mount Hood	3	960	8,450	283	163,980	1.95	171
Ochoco	28	8,735	108,230	1,145	898,765	.83	103
Rogue River	4	1,280	26,386	80	93,180	.35	73
Umatilla	13	3,705	35,676	611	383,650	1.07	104
Wallowa	3	790	9,440	106	80,735	.85	102
Whitman	9	2,877	25,460	427	354,750	1.39	123
Total	110	34,112	438,209	4,659	3,483,935	.80	102
INDIAN RESERVATIONS							
Klamath	19	11,200	110,000	1,339	1,120,000	1.01	100
Warm Springs	19	11,767	115,000	2,701	1,650,000	1.43	141
Total	38	22,967	225,000	4,040	2,770,000	1.23	121
PROTECTIVE ASSOCIATIONS							
Black Butte Fire Patrol	4	1,280	13,654	313	180,480	1.32	141
Klamath Forest Protective	12	6,488	83,414	824	716,965	.86	111
Oregon State Fire Patrol	2	590	4,478	207	83,860	1.87	142
Walker Range Fire Patrol	4	1,200	16,562	146	101,095	.61	84
Total	22	9,558	118,108	1,490	1,082,400	.93	113
OREGON TOTAL	170	66,637	781,317	10,189	7,336,335	.94	110
WASHINGTON							
NATIONAL FORESTS							
Chelan	4	1,280	11,180	86	53,460	.48	42
Colville	2	590	4,820	28	31,340	.65	53
Snoqualmie	2	605	9,801	35	27,140	.28	45
Wenatchee	4	1,200	10,160	50	33,630	.33	28
Total	12	3,675	35,961	199	145,570	.41	40
INDIAN RESERVATIONS							
Colville and Spokane	7	2,190	16,660	142	68,450	.41	30
Yakima	8	5,040	41,720	382	285,760	.68	57
Total	15	7,230	58,380	524	354,210	.61	49
PROTECTIVE ASSOCIATIONS							
Wash. State Fire Patrol	7	2,080	20,884	248	137,670	.66	66
WASHINGTON TOTAL	34	12,985	115,225	971	637,450	.55	49
REGION 6 TOTAL	204	79,622	896,542	11,160	7,973,785	.89	100

Table 2. Summary of Gross Losses of Ponderosa Pine on Virgin Check Plots, Season of 1939.

Administrative Areas	Check Plots			Ponderosa Pine Losses			
		Timbered	Pine		Volume		
	No.	Acres Cruised	Volume M Bd.Ft.	Trees	Board Feet	% of Stand	Bd. Ft. per Acre
OREGON							
NATIONAL FORESTS							
Deschutes	20	6,290	92,840	848	596,570	.64	95
Fremont	14	4,435	60,842	578	421,940	.70	95
Malheur	15	4,720	66,057	626	433,290	.66	92
Mount Hood	3	960	8,405	307	183,555	2.18	191
Ochoco	27	8,444	100,404	911	720,865	.85	72
Rogue River	4	1,280	26,295	89	123,750	.47	97
Umatilla	11	3,112	28,128	352	212,460	.75	68
Wallowa	3	790	9,363	31	31,480	.34	40
Whitman	9	2,877	25,100	209	151,545	.60	53
Total	106	32,908	417,431	3,951	2,875,455	.69	87
INDIAN RESERVATIONS							
Klamath	19	11,200	103,000	1,476	1,180,000	1.15	105
Warm Springs	10	6,092	59,000	1,727	1,070,000	1.81	176
Total	29	17,292	162,000	3,203	2,250,000	1.39	130
PROTECTIVE ASSOCIATIONS							
Black Butte Fire Patrol	4	1,280	13,473	356	209,260	1.55	163
Klamath Forest Protective	8	4,430	61,718	699	619,010	1.00	140
Oregon State Fire Patrol	2	590	4,384	88	39,240	.90	67
Walker Range Fire Patrol	4	1,200	16,461	188	161,075	.98	133
Total	18	7,500	96,036	1,331	1,028,585	1.07	137
OREGON TOTAL	153	57,700	675,467	8,485	6,154,040	.91	107
WASHINGTON							
NATIONAL FORESTS							
Chelan	4	1,280	11,130	146	72,705	.65	57
Colville	2	590	4,790	21	18,620	.39	31
Snoqualmie	2	605	9,774	81	40,310	.41	67
Wenatchee	5	1,520	14,234	119	53,060	.37	35
Total	13	3,995	39,928	367	184,695	.46	46
INDIAN RESERVATIONS							
Colville and Spokane	7	2,190	16,594	164	85,590	.52	41
Yakima	8	5,040	41,430	455	218,000	.53	43
Total	15	7,230	58,024	619	303,590	.52	42
PROTECTIVE ASSOCIATION							
Wash. State Fire Patrol	7	2,080	20,720	311	159,790	.77	77
WASHINGTON TOTAL	35	13,305	118,672	1,297	648,075	.55	49
REGION 6 TOTAL	188	71,005	794,139	9,782	6,802,115	.86	96

Table 3. Summary of Gross Losses of Ponderosa Pine on Virgin Check Plots, Season of 1940.

Administrative Areas	Check Plots			Ponderosa Pine Losses			
		Timbered	Pine Volume	Volume			
	No.	Acres Cruised	M Bd Ft.	Trees	Board Feet	% of Stand	Bd. Ft. per Acre
OREGON							
NATIONAL FORESTS							
Deschutes	16	5,010	78,580	211	174,630	.22	35
Fremont	14	4,215	61,908	512	362,300	.59	86
Malheur	12	3,758	53,365	470	295,460	.55	79
Mount Hood	3	960	8,058	549	330,530	4.00	330
Ochoco	26	8,124	96,481	821	630,920	.65	77
Rogue River	3	960	21,424	73	97,750	.46	102
Umatilla	11	3,072	28,080	244	150,640	.54	49
Wallowa	3	790	9,327	26	20,410	.22	26
Whitman	9	2,877	24,936	188	149,540	.60	52
Total	97	29,766	381,839	3,094	2,212,180	.58	75
INDIAN RESERVATIONS							
Klamath	15	8,960	82,000	1,130	800,000	.97	89
Warm Springs	10	6,092	58,000	2,137	1,500,000	2.58	246
Total	25	15,052	140,000	3,267	2,300,000	1.64	153
PROTECTIVE ASSOCIATIONS							
Black Butte Fire Patrol	4	1,280	13,265	413	280,600	2.12	220
Klamath Forest Protective	7	3,790	54,195	616	503,380	.93	133
Oregon State Fire Patrol	1	270	761	14	3,080	.41	11
Walker Range Fire Patrol	3	960	13,263	116	58,480	.44	61
Total	15	6,300	81,484	1,159	845,540	1.04	134
OREGON TOTAL	137	51,118	603,323	7,520	5,357,720	.89	105
WASHINGTON							
NATIONAL FORESTS							
Chelan	4	1,280	11,080	141	75,640	.68	59
Colville	2	590	4,780	44	37,590	.79	64
Snoqualmie	2	605	9,760	61	36,690	.38	62
Wenatchee	3	880	8,410	100	34,240	.42	39
Total	11	3,355	34,030	346	184,160	.54	55
INDIAN RESERVATIONS							
Colville and Spokane	7	2,180	16,550	161	83,100	.50	38
Yakima	8	5,040	41,200	601	353,675	.86	70
Total	15	7,220	57,750	762	436,775	.76	61
PROTECTIVE ASSOCIATION							
Wash. State Fire Patrol	5	1,540	14,590	237	105,840	.73	69
WASHINGTON TOTAL	31	12,120	106,370	1,345	726,775	.68	60
REGION 6 TOTAL	168	63,238	709,693	8,865	6,084,495	.86	96

Table 4. Summary of Gross Losses of Ponderosa Pine
On Virgin Check Plots, Season of 1941.

Administrative Areas	Check Plots			Ponderosa Pine Losses			
	Timbered	Pine		Volume			
	No.	Acres Cruised	Volume M Bd.Ft.	Trees	Board Feet	% of Stand	Bd. Ft. per Acre
OREGON							
NATIONAL FORESTS							
Deschutes	9	2,880	56,900	228	199,130	.35	69
Fremont	13	4,165	51,620	163	194,650	.38	47
Malheur	11	3,513	45,600	247	206,450	.45	59
Mount Hood	3	960	7,750	374	237,650	3.04	247
Ochoco	20	6,114	71,200	376	326,320	.46	53
Rogue River	2	640	14,500	29	56,610	.39	89
Umatilla	5	1,360	12,500	121	95,710	.77	70
Whitman	6	1,917	16,500	181	138,580	.83	72
Total	69	21,549	276,570	1,719	1,455,100	.53	68
INDIAN RESERVATIONS							
Klamath	8	2,560	35,990	109	102,280	.28	40
Warm Springs	6	1,920	25,500	303	178,300	.75	93
Total	14	4,580	61,490	412	280,580	.46	59
PROTECTIVE ASSOCIATIONS							
Black Butte Fire Patrol	4	1,280	12,100	586	357,120	2.95	279
Klamath Forest Protective	7	3,490	47,260	225	251,310	.53	72
Oregon State Fire Patrol	1	270	760	13	3,680	.48	14
Walker Range Fire Patrol	3	960	13,130	70	24,460	.19	25
Total	15	6,000	73,250	894	636,570	.87	106
OREGON TOTAL	98	32,129	411,310	3,025	2,374,250	.58	74
WASHINGTON							
NATIONAL FORESTS							
Chelan	4	1,280	11,960	97	51,220	.43	40
Snoqualmie	2	605	9,630	100	70,260	.73	116
Wenatchee	2	640	6,800	101	39,810	.59	62
Total	8	2,525	28,390	298	161,290	.57	63
INDIAN RESERVATIONS							
Colville and Spokane	4	1,250	9,710	56	30,030	.31	26
Yakima	6	1,880	15,900	241	180,190	1.13	96
Total	10	3,130	25,110	297	210,220	.84	67
PROTECTIVE ASSOCIATION							
Wash. State Fire Patrol	5	1,540	17,200	169	103,120	.60	67
WASHINGTON TOTAL	23	7,195	71,200	764	474,630	.67	66
REGION 6 TOTAL	121	39,324	482,510	3,789	2,858,880	.60	72

Table 5. Summary of Gross Losses of Ponderosa Pine on Virgin Check Plots, Season of 1942.

Administrative Areas	Check Plots			Ponderosa Pine Losses			
	Timbered	Pine		Volume			
	No.	Acres Cruised	Volume M Bd. Ft.	Trees	Board Feet	% of Stand	Bd. Ft. per Acre
OREGON							
NATIONAL FORESTS							
Deschutes	9	2,880	56,800	213	184,280	.32	64
Fremont	12	3,855	48,710	137	134,630	.28	35
Malheur	9	2,873	38,900	194	166,090	.43	58
Mount Hood	2	640	5,550	234	178,130	3.22	279
Ochoco	15	4,669	52,100	295	237,470	.46	51
Rogue River	2	640	14,500	10	19,620	.14	31
Umatilla	5	1,350	14,500	44	36,960	.25	27
Wallowa	1	200	2,100	6	4,060	.19	20
Whitman	6	1,917	14,200	125	72,070	.51	38
Total	61	19,024	247,360	1,258	1,033,310	.42	54
INDIAN RESERVATIONS							
Klamath	6	1,920	26,430	79	87,860	.33	46
Warm Springs	7	2,170	25,440	516	274,450	1.08	126
Total	13	4,090	51,870	595	362,310	.70	89
PROTECTIVE ASSOCIATIONS							
Black Butte Fire Patrol	3	960	10,500	535	315,070	3.00	328
Klamath Forest Protective	5	2,560	34,360	89	101,860	.30	40
Walker Range Fire Patrol	1	320	5,430	22	18,570	.34	58
Total	9	3,840	50,290	646	435,500	.87	113
OREGON TOTAL	83	26,954	349,620	2,499	1,831,120	.52	68
WASHINGTON							
NATIONAL FORESTS							
Chelan	2	640	5,200	43	28,630	.55	45
Snoqualmie	2	605	9,630	64	56,370	.59	93
Wenatchee	1	320	3,700	25	12,640	.34	40
Total	5	1,565	18,530	132	97,640	.53	63
INDIAN RESERVATIONS							
Colville	5	1,550	11,700	66	33,710	.29	22
Yakima	6	1,850	15,900	227	187,290	1.18	101
Total	11	3,400	27,600	293	221,000	.80	65
PROTECTIVE ASSOCIATIONS							
Wash. State Fire Patrol	4	1,250	12,660	91	51,070	.40	41
WASHINGTON TOTAL	20	6,215	58,790	516	369,710	.63	60
REGION 6 TOTAL	103	33,169	408,410	3,015	2,201,030	.54	67

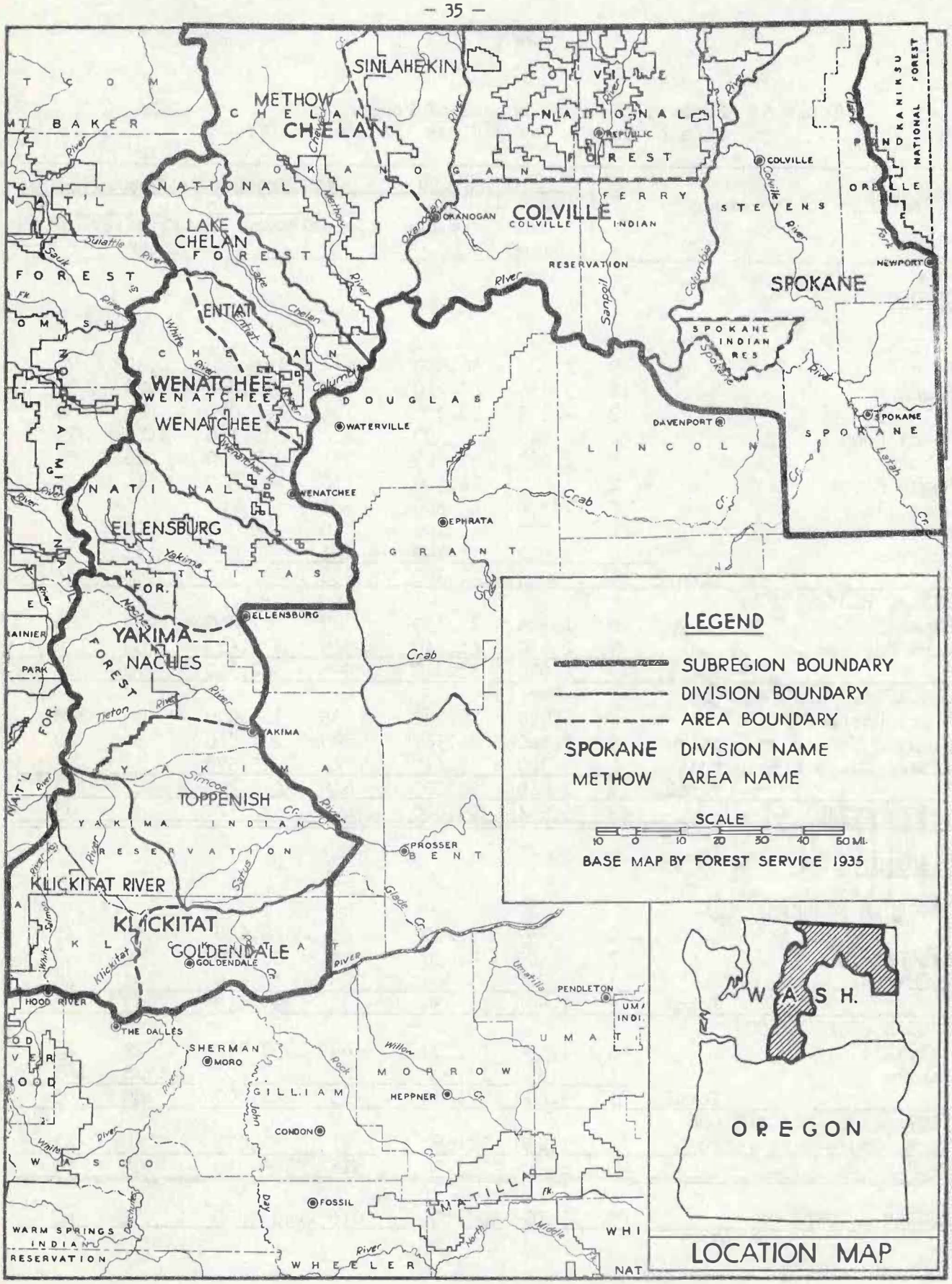

FIGURE 3. ENTOMOLOGICAL SUBDIVISIONS OF THE PONDEROSA PINE REGION
EASTERN WASHINGTON SUBREGION

Table 6. Estimated Percent of Stand Killed, Eastern Washington Subregion, 1938-1942.

Division and Area	1938	1939	1940	1941	1942	10-Year Total 1931-1940
Spokane Division						
Spokane Area	0.5	0.5	0.4	0.4	0.3	5.1
Spokane Indian Reservation	0.9	0.7	1.0	0.8	0.6	11.6
Colville Division						
Colville National Forest	0.5	0.4	0.5	0.4	0.3	9.8
Colville Indian Reservation	0.6	0.6	0.6	0.5	0.5	7.4
Chelan Division						
Sinlahekin Area	0.1	0.1	0.1	0.1	0.1	9.3
Methow Area	1.2	0.8	0.7	0.5	0.6	12.7
Wenatchee Division						
Lake Chelan Area	1.0	0.5	0.2	0.2	0.1	11.7
Entiat Area	0.5	0.4	0.2	0.3	0.2	10.1
Wenatchee Area	0.4	0.4	0.4	0.5	0.3	6.1
Yakima Division						
Ellensburg Area	0.3	0.2	0.3	0.3	0.2	5.4
Naches Area	0.4	0.4	0.5	0.9	0.7	5.8
Toppenish Area	0.6	0.5	0.7	0.7	0.8	5.7
Klickitat Division						
Goldendale Area	0.8	0.7	1.0	0.7	0.5	17.5
Klickitat River Area	0.7	0.6	0.5	0.4	0.3	11.6

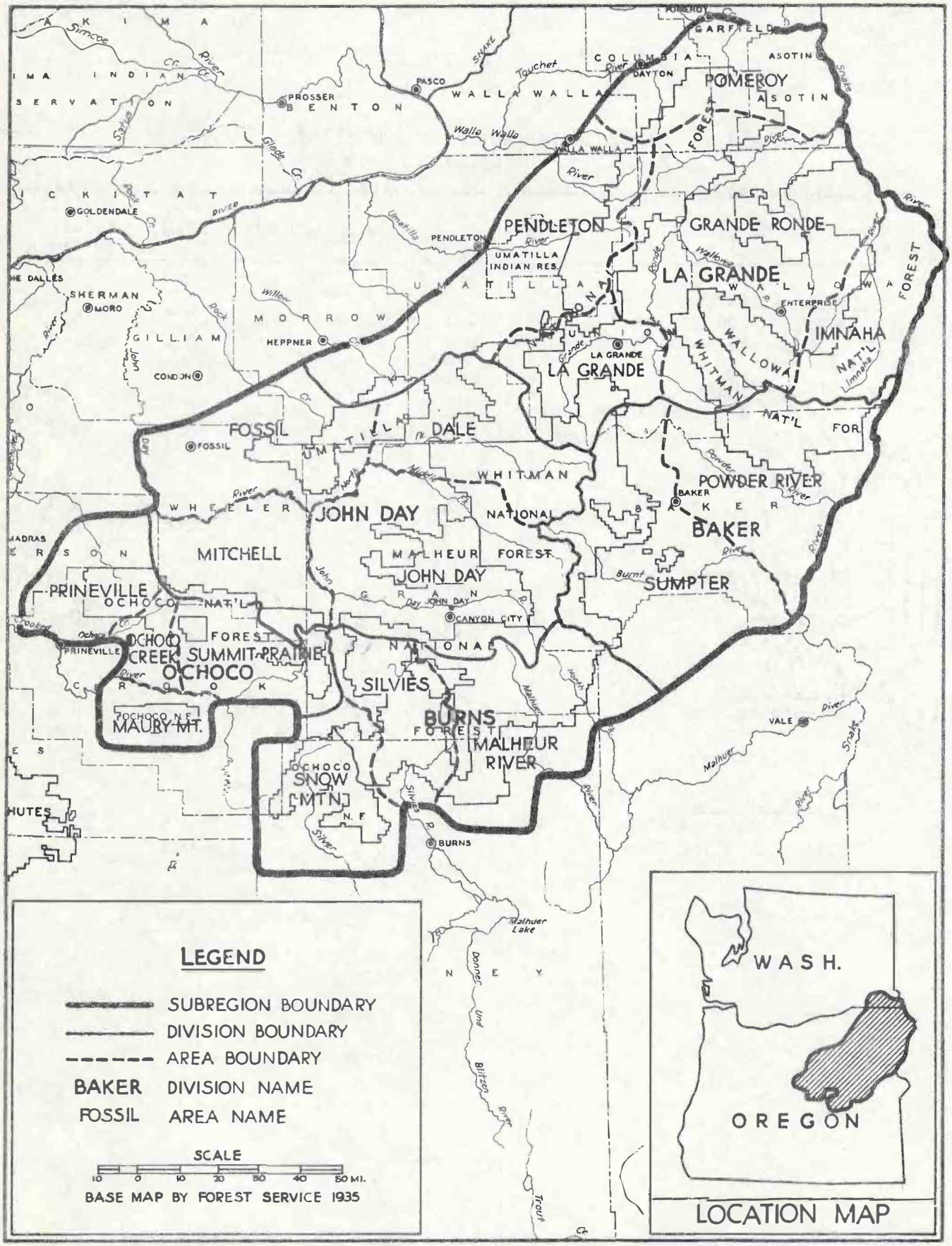

FIGURE 4. ENTOMOLOGICAL SUBDIVISIONS OF THE PONDEROSA PINE REGION
BLUE MOUNTAINS SUBREGION

Table 7. Estimated Percent of Stand Killed, Blue Mountains Subregion, 1938-1942.

Division and Area	1938	1939	1940	1941	1942	10-Year Total 1931-1940
Ochoco Division						
Prineville Area	0.6	0.4	0.4	0.3	0.3	16.3
Ochoco Creek Area	0.6	0.6	0.6	0.4	0.3	18.8
Maury Mountain Area	0.9	0.6	0.5	0.5	0.4	18.0
Summit Prairie Area	0.6	0.3	0.3	0.3	0.2	10.0
John Day Division						
Fossil Area	1.3	1.1	0.7	0.6	0.4	17.2
Dale Area	0.4	0.4	0.3	0.3	0.2	6.1
Mitchell Area	0.7	0.5	0.4	0.4	0.3	13.6
John Day Area	0.6	0.6	0.5	0.4	0.3	9.0
Burns Division						
Snow Mountain Area	1.3	1.1	0.9	0.6	0.4	22.3
Silvies Area	0.9	0.7	0.6	0.4	0.3	8.5
Malheur River Area	0.4	0.5	0.4	0.4	0.4	7.2
La Grande Division						
Pendleton Area	0.3	0.2	0.1	0.2	0.1	7.1
La Grande Area	0.4	0.3	0.2	0.2	0.1	5.0
Grand Ronde Area	0.9	0.5	0.3	0.3	0.2	7.0
Imnaha Area	0.4	0.1	0.1	0.1	0.1	7.6
Pomeroy Area (Wash.)	1.1	0.3	0.2	0.1	0.1	6.6
Baker Division						
Powder River Area	0.5	0.3	0.2	0.3	0.3	5.3
Sumpter Area	0.7	0.5	0.5	0.5	0.4	8.4

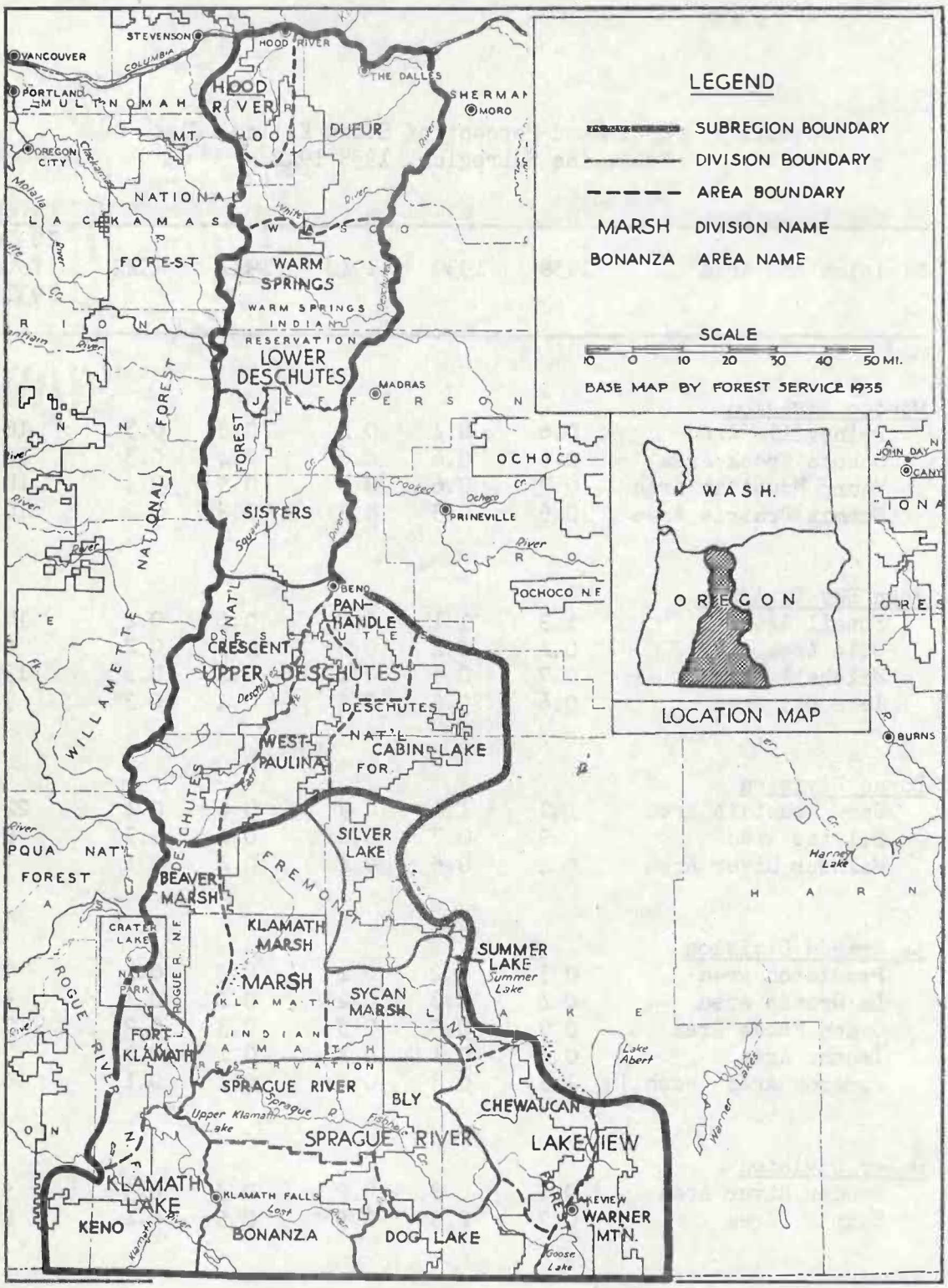

FIGURE 5. ENTOMOLOGICAL SUBDIVISIONS OF THE PONDEROSA PINE REGION DESCHUTES AND KLAMATH SUBREGIONS

Table 8. Estimated Percent of Stand Killed, Klamath and Deschutes Subregions, 1938-1942.

Subregion, Division, and Area	1938	1939	1940	1941	1942	10-Year Total 1931-1940
KLAMATH SUBREGION						
Klamath Lake Division						
Keno Area	0.5	0.5	0.7	0.3	0.2	8.7
Fort Klamath Area	0.3	0.4	0.6	0.3	0.2	6.0
Sprague River Division						
Bonanza Area	0.9	0.9	0.8	0.2	0.2	12.7
Bly Area	0.9	0.9	0.8	0.5	0.3	16.4
Sprague River Area	1.0	0.9	0.9	0.5	0.3	14.8
Marsh Division						
Beaver Marsh Area	0.3	0.4	0.3	0.4	0.5	6.2
Klamath Marsh Area	0.6	0.9	0.7	0.3	0.6	11.2
Sycan Marsh Area	0.5	0.9	0.7	0.3	0.2	12.1
Lakeview Division						
Dog Lake Area	0.6	0.6	0.7	0.3	0.2	8.5
Chewaucan Area	0.8	0.9	0.5	0.3	0.2	10.3
Warner Mountain Area	0.5	0.5	0.4	0.2	0.1	5.4
Silver Lake Area	0.9	0.9	0.8	0.7	0.5	16.0
Summer Lake Area	1.2	1.3	0.9	0.7	0.5	12.7
DESCHUTES SUBREGION						
Lower Deschutes Division						
Dufur Area	1.0	1.1	2.0	1.5	1.7	14.1
Warm Springs Area	1.0	1.1	1.5	.9	1.2	13.0
Sisters Area	0.8	0.9	0.8	1.0	1.2	8.6
Upper Deschutes Division						
Crescent Area	0.3	0.4	0.3	0.4	0.3	5.5
West Paulina Area	0.4	0.6	0.3	0.3	0.5	6.8
Cabin Lake Area	0.8	0.9	0.7	0.3	0.3	13.8
Panhandle Area	0.8	0.7	0.3	0.7	0.5	18.1

Table 9. Total Estimated Ponderosa Pine Losses in Million Board Feet, Eastside Oregon and Washington, 1921-1942.

Period	Oregon	Washington	Total
1931	910	130	1,040
1932	1,440	270	1,710
1933	640	210	850
1934	660	120	780
1935	520	60	580
1936	400	60	460
1937	320	60	380
1938	430	80	510
1939	390	90	480
1940	350	90	440
1941	250	100	350
1942	210	60	270
	Decadal Losses		
1921	6,900	1,350	8,250
1931	6,060	1,170	7,230

Table 10. Pine Beetle Control Work Conducted from the Fall of 1938 to the Spring of 1939.

Forest and Project	Acres Covered	Trees Treated	Volume Treated M.b.m.	Cost	Work done by
Western Pine Beetle Control in Ponderosa Pine					
Private land, Klamath County					
Deming and Meryl Creek	12,560	3,079	-----	$ 8,375	Klamath Forest Protective Assoc.
Klamath Indian Reservation	38,060	4,739	2,343	33,296	Office of Indian Affairs
Warm Springs Indian Reservation	32,400	6,208	3,911	26,040	Office of Indian Affairs
Mountain Pine Beetle Control in White Pine					
Mount Rainier National Park	---	128	-----	768	National Park Service

Table 11. Pine Beetle Control Work Conducted from the Fall of 1939 to the Spring of 1940.

Forest and Project	Acres Covered	Trees Treated	Volume Treated M.b.m.	Cost	Work done by
Western Pine Beetle Control in Ponderosa Pine					
Deschutes National Forest, Metolius	65,000	3,345	----	$11,613	Forest Service (CCC and Regular funds)
Fremont National Forest and private lands					
Cox Creek	2,680	299	234	1,638	Forest Service (Regular funds)
Antelope Mountain	10,400	902	610	5,571	Forest Service (Regular funds)
Antelope Mountain	13,660	635	---	2,413	Klamath Forest Protective Assoc.
Meryl Creek	900	1,629	---	4,040	Klamath Forest Protective Assoc.
Ochoco National Forest, Maury Mountain	3,240	263	---	1,177	Forest Service (Regular funds)
Warm Springs Indian Reservation	22,760	5,485	3,538	21,681	Office of Indian Affairs
Mountain Pine Beetle Control in White Pine					
Mount Rainier National Park	---	115	---	690	National Park Service

Table 12. Pine Beetle Control Work Conducted from the Fall of 1940 to the Spring of 1941.

Forest and Project	Acres Covered	Trees Treated	Volume Treated M.b.m.	Cost	Work done by
Western Pine Beetle Control in Ponderosa Pine					
Deschutes National Forest, Metolius	65,000	4,008		$10,635	Forest Service (CCC and regular funds) Jan. 1 to March 17, 1941
Fremont National Forest and private lands	----	----	----	----	---
Chewaucan	13,700	750		4,215	Forest Service (regular funds)
Chewaucan	10,680	719		3,825	Klamath Forest Protective Assoc. fall of 1940
Swamp Creek-Coleman	5,240	371	----	3,140	Forest Service (regular funds) spring of 1941
Malheur National Forest	----	----	----	----	----
Bear Valley - Canyon Creek	28,300	1,468	----	12,140	Forest Service (CCC and regular funds)
Bear Valley - Jack Creek	----	252	----	(salvage)	Edward Hines Lumber Co.
Mountain Pine Beetle Control in White Pine					
Mount Rainier National Park	---	425	----	1,790	National Park Service

Table 13. Total Expenditures for Forest Insect Control and Research During the Fiscal Years 1938-1942

Western Pine Beetle Control	Total Expenditures
Office of Indian Affairs	$81,017
Forest Service	50,129
Private timber owners	18,653
	$149,799
Mountain Pine Beetle Control	
National Park Service	3,248
Forest Insect Research, Surveys and Service	
Bureau of Entomology and Plant Quarantine	106,520
TOTAL	$259,567

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* (2) Longevity of ponderosa pine. Jour. Forestry 38(7): 597-598. 1940.

(3) Review of Graham's "Principles of Forest Entomology". Jour. Forestry. 38(4): 370-371. 1940.

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* (8) The western hemlock sawfly (Neodiprion tsugae Middleton) and its parasites in Oregon. Jour. Econ. Ent. 34(1): 46-52. 1941.

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(9) Report of general service work and extension for calendar year 1940. March 7, 1941.

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(10) Report of general service work and extension for calendar year 1938. September 1939.

(11) Report of general service work and extension for calendar year 1939. March 6, 1940.

(12) Report of general service work and extension for calendar year 1941. February 5, 1942.

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(13) A brief review of forest insect problems in the Pacific Northwest. December 12, 1939.

(14) Forest Insect control problems in the Pacific Northwest. June 10, 1941.

(15) A program of forest insect investigations for the Pacific Northwest, 1941-1950. August 21, 1941.

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Keen, F. P.

(16) Low temperature differentials in one forest drainage. June 26, 1941.

Ponderosa pine susceptibility studies

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NATIONAL FOREST REPORTS (continued)

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NATIONAL FOREST REPORTS (continued)

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FOREST INSECT SURVEY REPORTS (continued)

NATIONAL FOREST REPORTS (continued)

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Whiteside, J. M.

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INDEX TO SPECIES OF INSECTS DISCUSSED

Page

Ambrosia beetles.....27
Aphis abietina Walk.....24
Archips fumiferana (Clem.).....23
Argyresthia cupresella Wlsm.....25
Asemum atrum Esch.....27
Balsam woolly aphid.....24
Buprestids.....27
Buprestis aurulenta L.....27
Buprestis langi Mann.....27
Camponotus spp.....25
Carpenter ants.....25
Chermes piceae Ratz.....24
Criocephalus productus Lec.....27
Cylindrocopturus furnissi Buch.....22
Cypress leaf miner.....25
Dendroctonus brevicomis Lec..... 2
Dendroctonus monticolae Hopk.....20
Dendroctonus Pseudotsugae Hopk.....21
Douglas fir beetle.....21
Douglas fir tussock moth.....22
Douglas fir twig weevil.....22
Elm leaf beetle.....25
Erymnia nitida R. D.....25
Fir engraver.....22
Galerucella xanthomelaena (Schr.).....25
Hadrobregmus gibbicollis (Lec.).....26
Halisidota argentata Pack.....23
Hemerocampa pseudotsugata McD.....22
Hemlock looper.....22
Ips oregoni Eichh.....21
Lambdina fiscellaria lugubrosa (Hulst)...22
Lyctus spp.....26

Page

Malacosoma constricta (Stretch).....23
Malacosoma disstria Hbn.....23
Malacosoma fragilis (Stretch).....23
Malacosoma pluvialis (Dyar).....23
Malacosoma spp.....23
Matsucoccus bisetosus Morr.....24
Mountain pine beetle.....20
Neodiprion sp.....24
Oregon pine engraver.....21
Phytoptus pini Nalepa.....24
Pine needle mite.....24
Pine stem scale.....24
Pin hole borers.....27
Powder post beetles.....26
Reticulitermes hesperus Banks.....26
Roundheaded borers.....27
Satin moth.....25
Sawfly.....24
Scolytus ventralis Lec.....22
Silver-spotted halisidota.....23
Spruce aphid.....24
Spruce budworm.....23
Stilpnotia salicis (L.).....25
Tent caterpillars.....23
  Forest.....23
  Great Basin.....23
  Oak.....23
  Western.....23
Termites.....26
  Common damp-wood.....26
  Western subterranean.....26
Western pine beetle..... 2
Zootermopsis angusticollis (Hagen)..26